Community Model for Air Quality (CMAQ) V4.6.31 Upgrade

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31 July 2014

CMAQ Air Quality Forecasting System

NAM-12
NWS/NCEP

GSI

Weather Observations

MET
PREPHYB

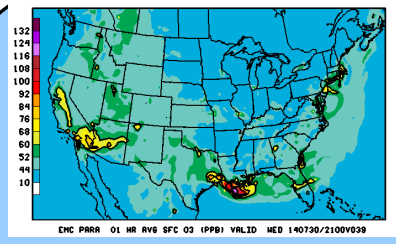
USFS BlueSky
(from HYSPLIT)

HMS Smoke &
Fire detection
NOAA/NESDIS

O3/PM
Emissions
PREMAQ

EPA AIRNOW O3/PM
observations

CMAQ CB05/
AERO-IV
EPA, OAR/ARL, NWS/NCEP



+ HI, AK

G2O FVS
NWS/NCEP

Courtesy Jianping Huang

V4.6.31 CB05/AERO-4 CMAQ

- **V4.6.2 :** April 28, 2014
  - Inclusion of latest EPA Carbon Bond 5 (CB05) chemical mechanism.
  - Inclusion of AERO-4 aerosol chemistry.
  - Updated anthropogenic emissions with 2014 Dept. Energy projections.

- **V4.6.3:** June 13, 2014
  - Modulate fugitive dust emission: suppress over ice/snow.
  - Incorporate NESIDS HMS wild fire smoke. ***CONUS***
  - Incorporate real-time surface dust emissions (wind dependent). ***CONUS***
  - *NTR, organic nitrate photolyzed and removed quicker.*
  - Layer specific time step was added to speed up code.

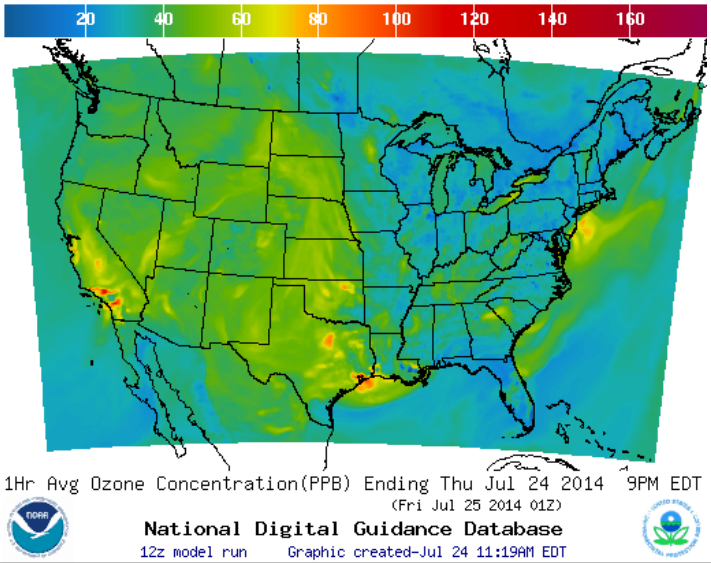
- **V4.6.3v2**: June 27, 2014
  - Correction to overestimates of dust emissions
    - repartition percent going to PM2.5, mix beyond first level

- **V4.6.31:** July 16, 2014
  - Turned off gas emissions from fires.
  - Ozone predictions will not be impacted by inclusion of smoke emissions.
  - **Remove NTR cycling**

Charter Overview

Expected Benefits to End Users

- **State Environmental Protection Agencies**
  Improved Ozone forecast
  More reliable PM2.5 product
  Inclusion of smoke and dust sources
- **Consistency** of all NCEP CMAQ applications running the same code
- **One system** to produce forecasts from all PM sources
- **Implement** PM2.5 AIRNOW verification.



NWS NDGD 1h Ozone Graphics: July 25, 01 UTC

Development testing

- CMAQ V4.6.3 runs at ARL
  - July 2011 Retrospectives:
    - Detailed comparison for Discover AQ field experiment

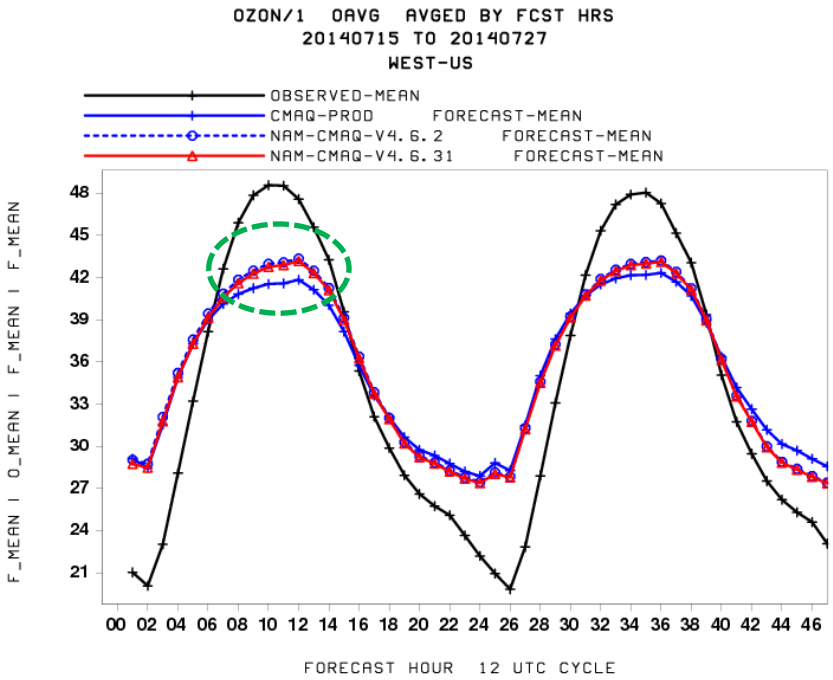
- Built and tested at EMC since June 13, 2014
  - EMC Frozen parallel since July 16, 2014
    - *ARL recommends additional changes*

- EMC Real-time and Retrospective Parallels
  - V4.6.2 : April 28, 2014 → Present
  - V4.6.3 : June 13 → July 22, 2014
  - V4.6.31 w/o gas emissions from fires : July 16, 2014 → Present

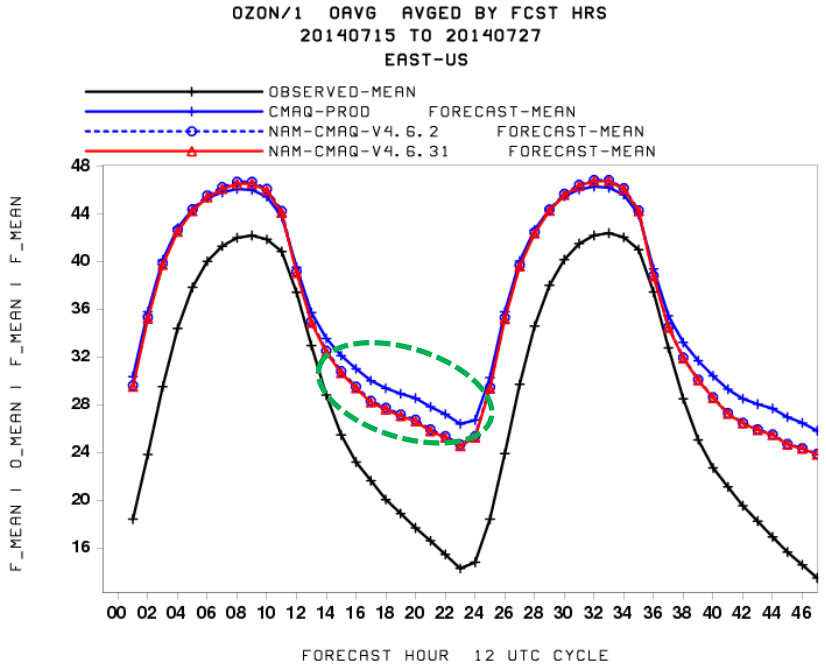
Recommended length of time for official evaluation parallel:

At least 30 days

1 hour Avg Ozone Performance
Observed, Prod, *V4.6.2*, V4.6.31



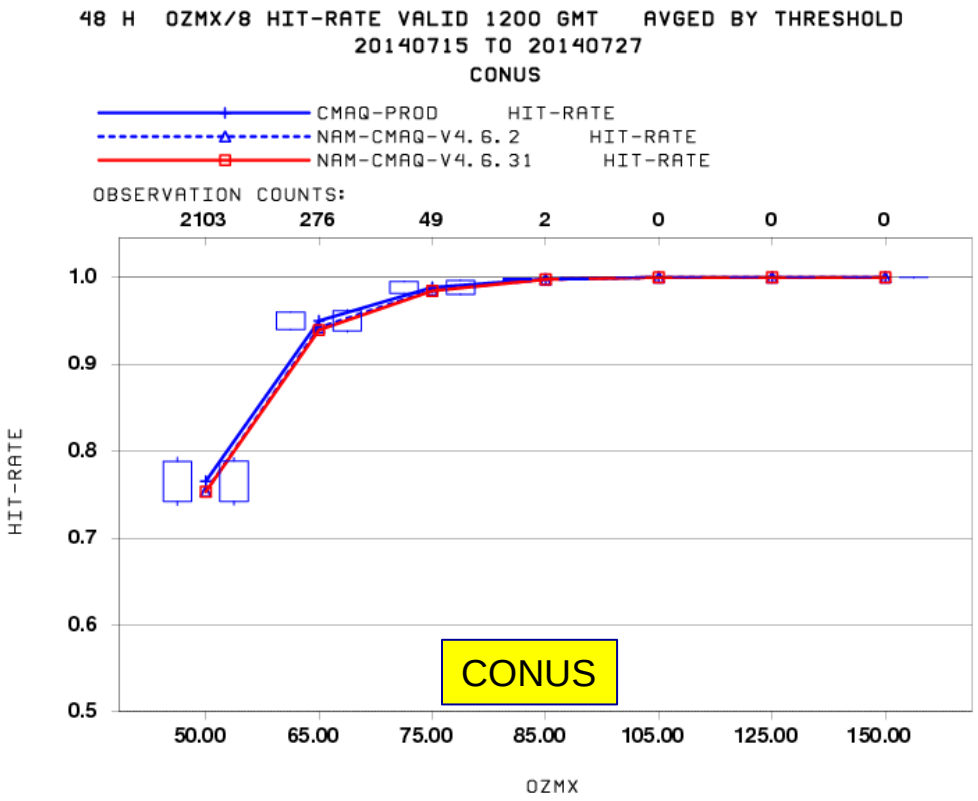
Western U.S.

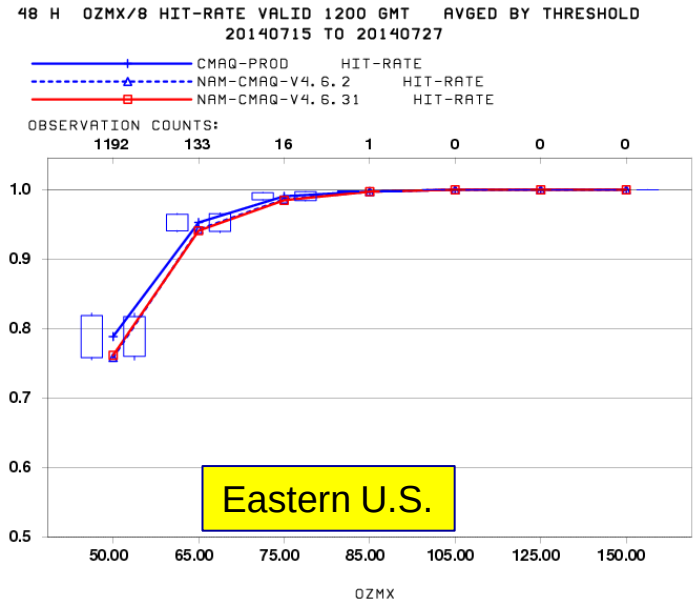


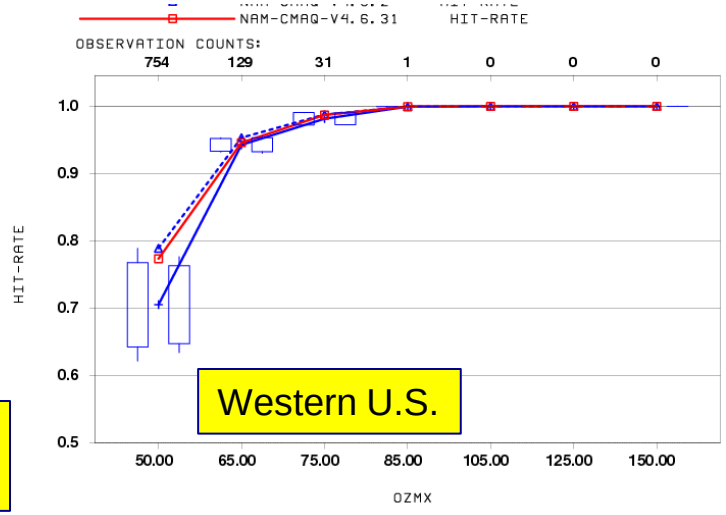
Eastern U.S.

Improvement in Western U.S esp during the day
Improvement in Eastern U.S. at night.

8 hour Avg Daily Max Ozone Performance
Skill Score: Prod, *V4.6.2*, V4.6.31

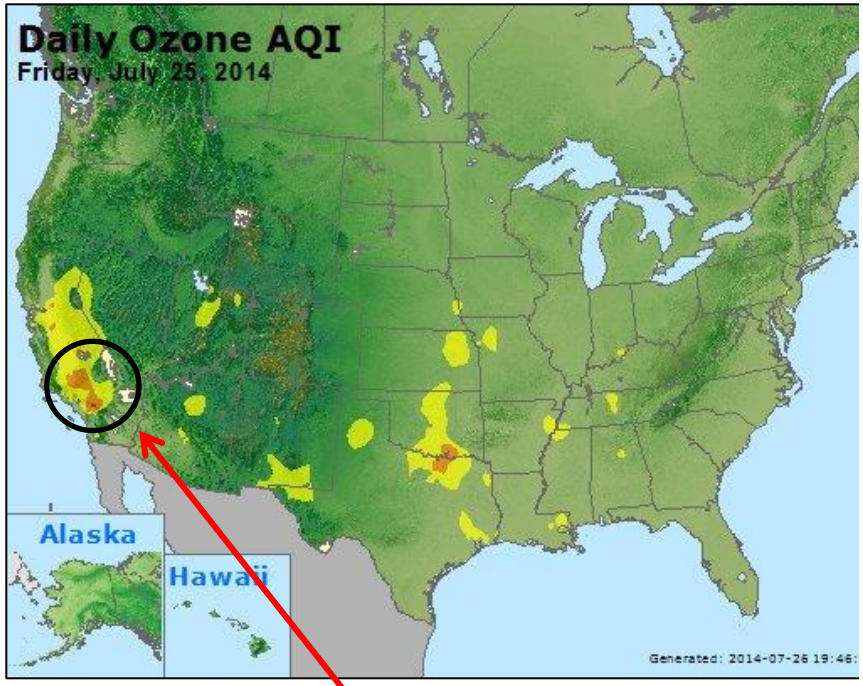




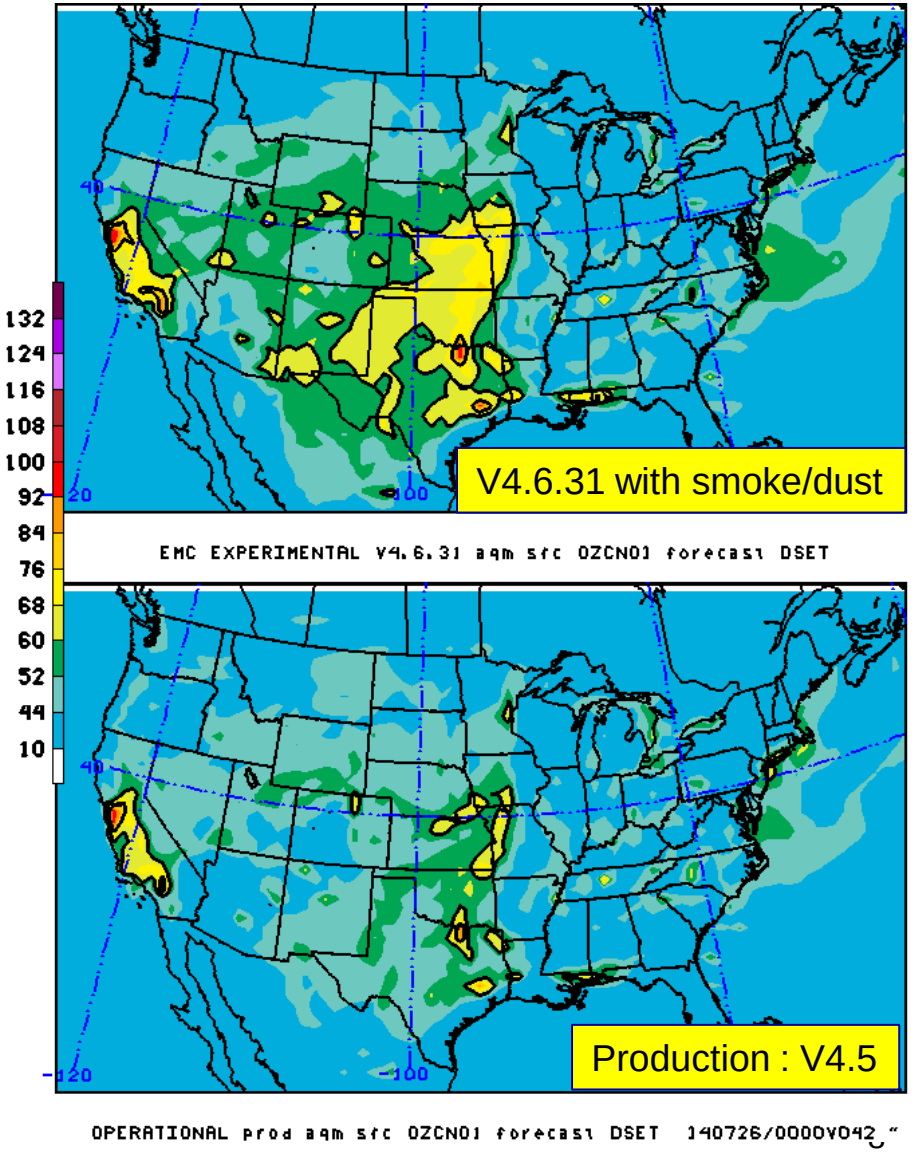


Some improvement in Western U.S
For lower thresholds (< 50 ppb)

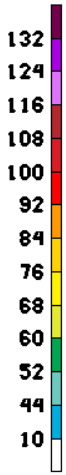
Ozone Predictions
July 25, 2014 Case

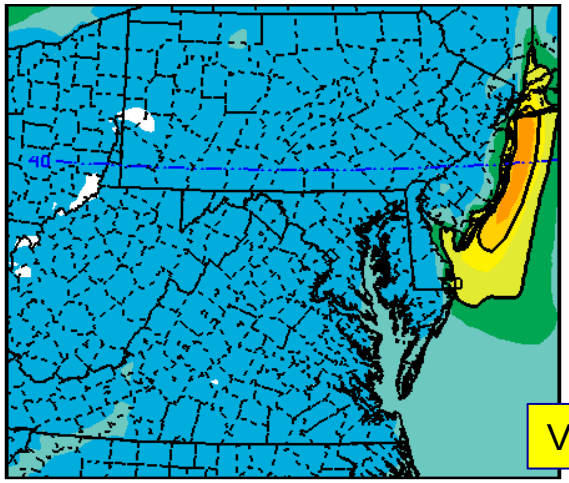


Experimental run better captures Code Orange Event in Southern California

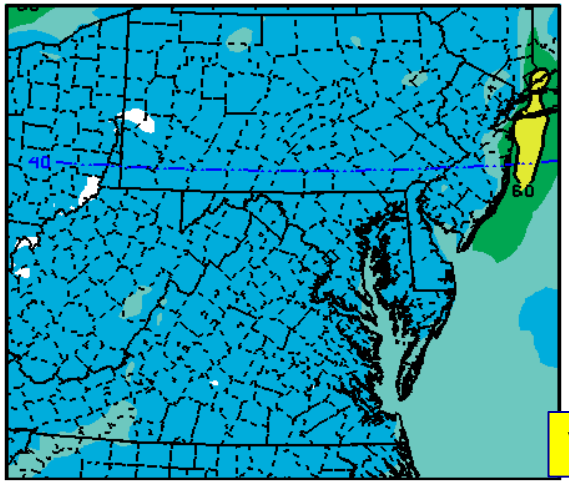


Initial Ozone Differences





EMC EXPERIMENTAL V4.6.3 aqm sfc OZCNO1 forecast S



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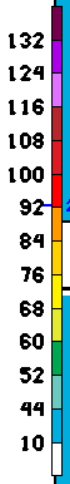
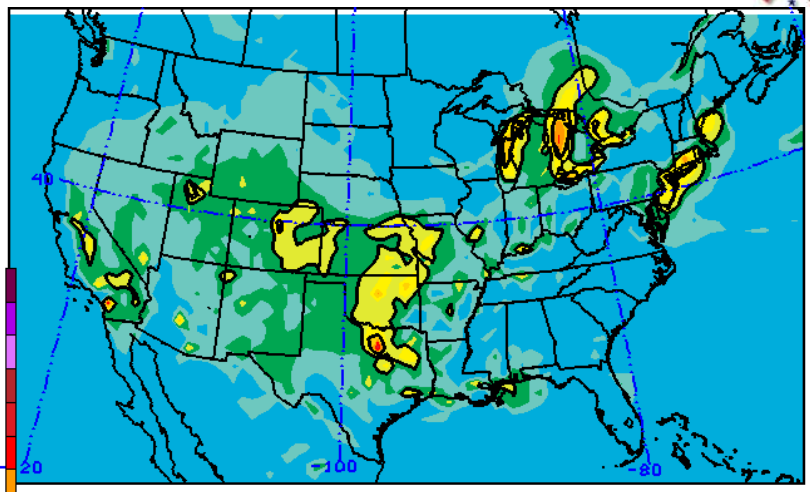
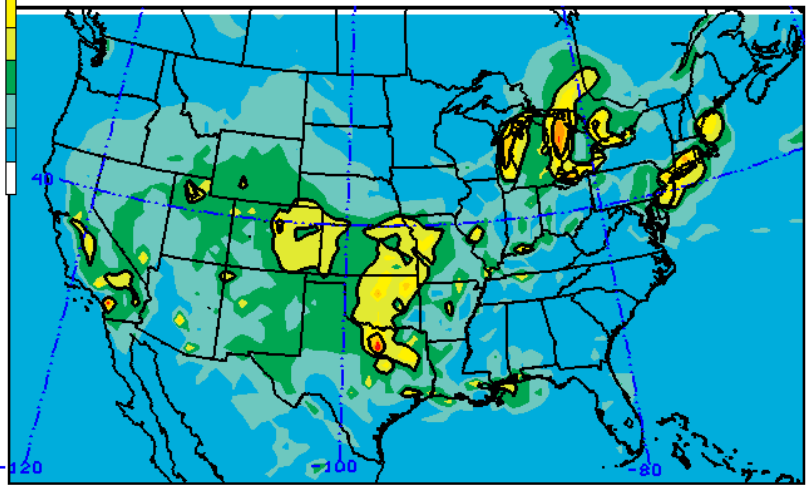




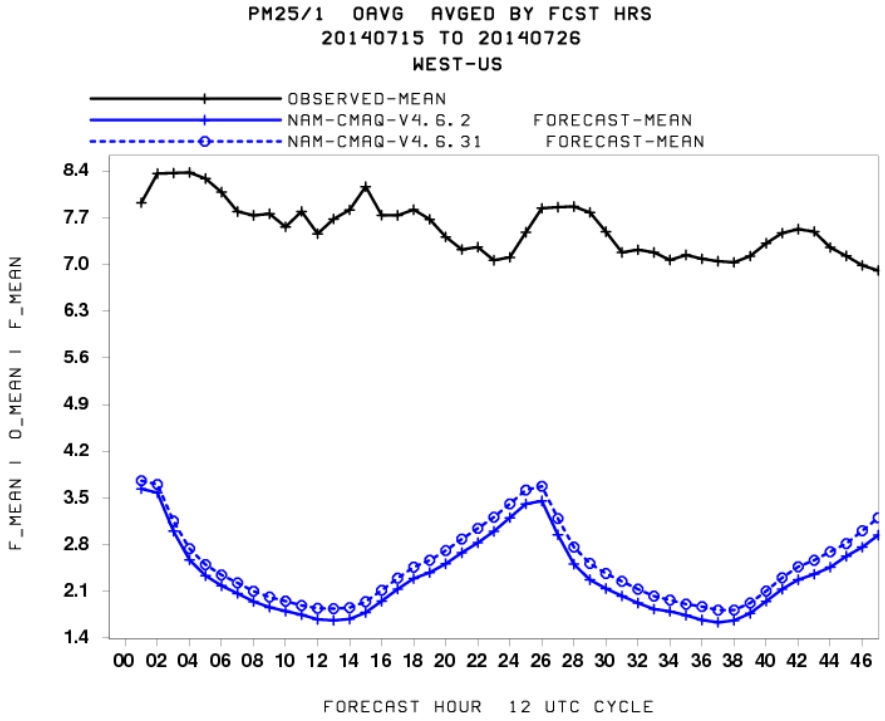
EMC EXPERIMENTAL V4.6.3 aqm sfc OZCNO1 forecast



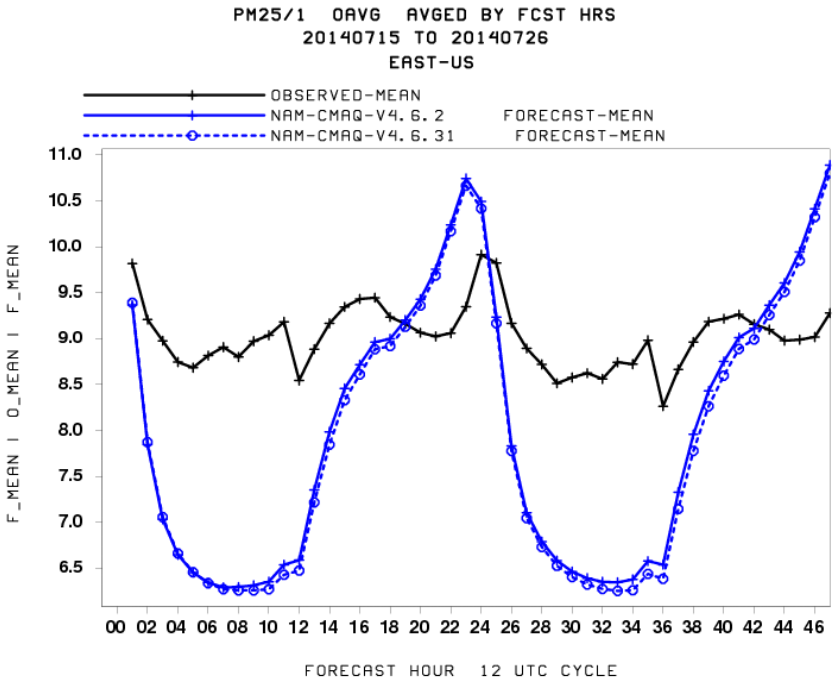
EMC EXPERIMENTAL V4.6.2 aqm sfc OZCNO1 forecast DSET 140723/0000V018 ~

Differences may be related to enhanced cycling of organic nitrogen

PM Performance
Obs, V4.6.2, *V4.6.31*
July 16-26



Western U.S.



Eastern U.S.

Inclusion of smoke/dust with V4.6.3 small
- Not enough cases ?

Testing Summary

- Preliminary ARL Retro July 2011 show improved performance
- EMC Parallel evaluation since July 16

EMC PARALLEL EVALUATIONS

V4.6.3/.31 : compared to current production

- Improved ozone performance
- Initial ozone plume over water differs
- Increased wall clock for smoke processing

compared to V4.6.2: slight improvement in PM2.5 prediction

PROPOSED EVALUATION TEAM

Organization	Recommended	Optional (nice to have)
NCEP Centers	EMC, NCO	
NCEP Service Centers	WPC, SPC	
NWS Region / WFO	ER, CR, SR, WR, AR	
Other NWS or NOAA components	OST	NWS/OS
External Customers / Collaborators	*NWS AQ focus group*	U.S. EPA, U.S. Forest Service

PROPOSED EVALUATION TEAM

Organization	Recommended	Individual	CMAQ Applications
NCEP Centers	EMC ARL NCO	Jianping Huang Pius Lee C. Caruso	Ozone, PM2.5
NCEP Service Centers	WPC SPC	Mike Bodner Philip Bothwell	Ozone, PM Smoke events
NWS Region / WFO	ER CR SR WR AR	Jeff Waldstriker Jeff Craven Jack Settelmeir Andy Edman Neil Petreskew	Ozone, PM2.5 with emphasis for fire weather smoke events PM2.5 non-smoke events
Other NWS or NOAA components	OST NESDIS	Ivanka Stajner Shobha Kondragunta	“ “
External Customers / Collaborators	NWS AQ focus group	State Dept of Envir. Protection office contacts provided by OST	“ “

JOB / RESOURCE REQUIREMENTS

New executables, jobs, and scripts :

JOBS: JAQM_{type}_{CS/AK/HI}

SCRIPTS: exaqm_{type}_{cs/ak/hi}.sh.ecf

sorc: aqm_{type}.fd

JOBS	SCRIPTS	ush	sorc
PREPHYB	prephyb_nmmb	prephyb_nmmb_{conus /ak/hi}_split	prep_nmmb
PREMAQ	premaq_cb05		premaq_nmmb_v46
FORECAST	cmaqv46		fcst_nmmb_v46
POST1	post1_cb05 post1_cb05{maxi}		post_maxi_CHA
POST2	post2_cb05		rdgrbwgt_aod_CHA
POST3	post3_cb05		cmaq2grib

JOB / RESOURCE REQUIREMENTS

New Smoke/dust processing for CONUS only

JOBS	SCRIPTS	ush	sorc
PREMAQ	premaq_cb05	premaq_hms_emission _cs.sh	fengsha fengsha_merge fire_checking smk_inven smk_merge snowdust
			EPA SMOKE SYSTEM: em_qa, em_mod, em_util, aqm_grdmat, aqm_point, aqm_spcmat, aqm_temporal

EE READINESS

- CMAQ V4.5 already uses vertical structure
  - /nwprod/cmaq.v4.5.0

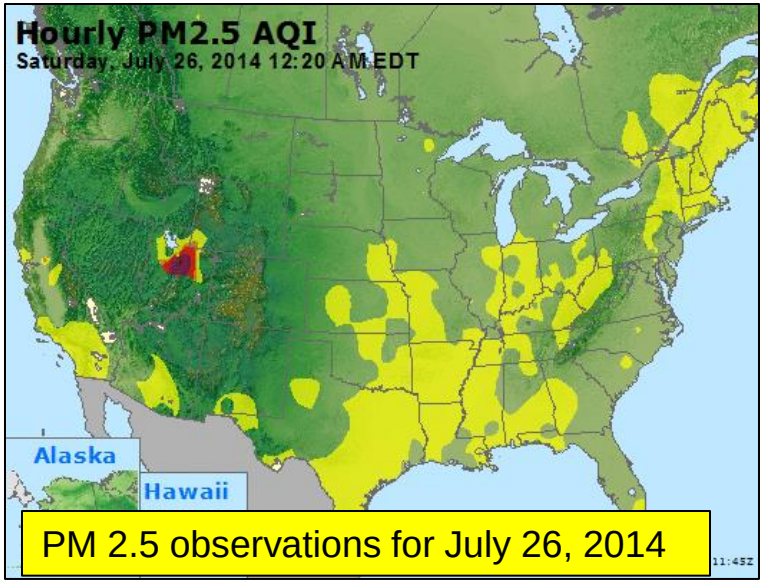
PRODUCT CHANGES

CMAQ currently generates:

- 12 km hourly surface ozone grib files hourly,
- 8 hourly ozone averages
- Day 1 and Day 2 one and eight hour average ozone daily maximum

- **Changes:**

  - Add 12 km hourly surface Particulate Matter 2.5 um (PM2.5) grib files (developmental product only)



PM 2.5 observations for July 26, 2014

New Product Volume & Run time (for CONUS run)

Disk Usage	Current Production	Expected New Production	Timing Increase
IBM Disk (/tmpnwprd, One 48 h run)	PREPHY: 45 GB PREMAQ: 19.4 GB CMAQ: 24 GB POST: 3 GB	PREPHY: same PREMAQ: 29.5 GB CMAQ: 52.7 GB POST: 18.5 GB	Same +25 mins +25 mins +5 mins
IBM Tape		+25 GB/cycle (pm files)	-
NCEP FTP Server (/com)	115 GB/day	303 GB/day	-
NWS FTP Server	similar minimal	No change	-

DEPENDENCIES

UPSTREAM: NAM,
NESDIS HMS smoke locations
USFS Bluesky emissions (from HYSPLIT run)
Monthly updated anthropogenic emissions

Upstream dependency requires following enhancements:

- Check for HMS/Bluesky smoke emission files from 06 Z Hysplit smoke run (on hysplit smoke /com directory)

DOWNSTREAM: NDGD

Downstream dependency requires following enhancements:

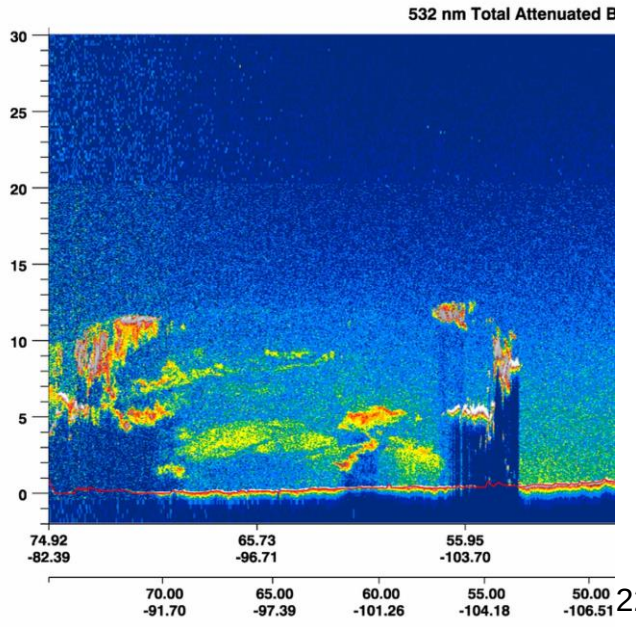
- None: Continue to provide GRIB2 files on AWIPS grids by 11:00 and 17:00 UTC to TOC and NDGD.

TIN: To be prepared and issued by or before Sept. 15 by OST

CODE DELIVERY: August 4, 2014

Remaining Issues

- Ozone predictions similar to production with latest changes to V4.6.31
- Increased smoke preprocessing time delays product availability
- CMAQ dependent on HYSPLIT smoke processing
- Only 2 weeks of EMC parallels performed
  - Prefer at least one month of frozen code evaluation
  - Few cases with significant smoke emissions available
- Additional change to CMAQ (NTR) recommended
- Awaiting latest ARL retrospective evaluation
- Short staffed for August
  - *ARL to support R-T runs w devmax*



CALIPSO overpass of July 24, 2014 major Canadian fires. Complicated multi-layer plume pattern observed.

OPTIONS

for NCO code handoff

1. Provide well-tested V4.6.2 by August 4
   - No smoke/dust sources for U.S.
   - Improvements for PM over snow cover not available

2. Provide V4.6.31 w smoke/dust emissions by August 4
   - *Few cases with smoke/dust impacts*
   - *Have not evaluated Alaska/Hawaii runs*
   - *Need to rerun with NTR cycling turned on*
   - ❖ *Can complete the evaluation during 30 day NCO parallel*

3. *Fully test latest recommended version V4.6.3X by September 4*
   - ❖ *Complete ARL retrospective analysis would be available*
   - ❖ *Typical 30 day EMC parallel would be performed for all domains*
   - ❖ *Fully test HYSPLIT smoke emissions dependencies*
   - ❖ *Jianping Huang, EMC code designer, will be available*
   - *Need buy-in from NWS Project Manager and full AQ team for delay*

AQ Upgrades to Emissions/Chemistry (CMAQ)
Project Status as of 4/17/2015

G Project Information and Highlights

Lead: Jeff McQueen & Jianping Huang, EMC; Chris Magee, NCO

Scope:

1. Upgrade CMAQ to version 4.6 with improved chemistry mechanism (CB05) & vertical transport.
2. Upgrade emissions with 2005 base year estimates and projections.
3. Improve fugitive dust and smoke emissions.
4. Inclusion of upgraded AERO-4 aerosol mechanism *(note PM products will still be developmental).*
5. ~~NGAC lateral boundary conditions~~
6. ~~PM bias correction~~

Expected Benefits:

1. Expansion of the AQFS whereby the AQM is incrementally improved through improved chemistry and physics.
2. Implementation of a unified system for all NCO CMAQ runs.
3. Improved vertical transport, emissions, unified system for all regional runs (AK and HI domains already running CMAQ V4.6).
4. ~~Real-time dust lateral boundary conditions from NGAC~~.

G Scheduling

Milestone (NCEP)	Date	Status
EMC NCO Kickoff Meeting	~~04/12/2014~~	
EMC testing complete/ EMC CCB approval	~~05/11/2014~~	
Final RFC submitted to NCO	~~05/12/2014~~	8/04/2014
Technical Information Notice Issued	07/18/2014	
Initial Test Complete	~~06/06/2014~~	08/15
CCB approve parallel data feed	~~06/10/2014~~	08/19
IT testing begins	~~06/09/2014~~	08/18
IT testing ends	~~06/30/2014~~	08/31
Parallel testing begun in NCO	~~07/01/2014~~	9/01
Real-Time Evaluation Ends	~~08/01/2014~~	10/01
Management Briefing	~~08/15/2014~~	10/15
Implementation	08/19/2014	10/19

G Issues/Risks

Issues: Based on EMC priority and NCO resource availability, scheduling is not possible at this time

Risks:.

- ~~ESRL/PSD Bias correction code may not be available in time~~.

Mitigation: Defer bias correction(and other unexpected delayed upgrades to FY15.

G Finances

Associated Costs:

Funding Sources: NAQFC : T2O 4 Man-months
NAQFC: 2 man-months for implementation, 1 man-month annually for maintenance.
Additional resources for extended development, testing and eval

R	Management Attention Required	Y	Potential Management Attention Needed	G	On Target